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Zero Retries is an independent newsletter about technological innovation in Amateur Radio.

About Zero Retries

Steve Stroh N8GNJ, Editor

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- **Request To Send - Big Subscriber Boost!**
- ***GEO! GEO!! GEO!!!***
- **Join the *Fun* on Amateur Radio**
- **Closing The Channel**

Request To Send

Welcome! to the 75 (and continuing to increase) new Zero Retries subscribers that joined in the past week. Most of you seem to have discovered Zero Retries from a generous mention by Andreas Spiess HB9BLA on his YouTube channel HB9BLA Wireless, in this episode:

Zero Retries hit 500 subscribers as of Zero Retries 0075 only two weeks ago, so that big bump, to ~575 is welcome!

I planned to discuss HB9BLA's video and dive deeper into **Rattlegram / Ribbit**, but unfortunately it got crowded out by the big story this week. Look for that discussion in Zero Retries 0078 next week.

Another nice mention of Zero Retries was from Tom Salzer KJ7T in his personal newsletter / blog - Tom Scribbles:

> But there *are* blogs that I would consider supporting in the form of a paid subscription. Steve Stroh's **Zero Retries** blog on Substack is one. Steve writes and publishes regularly, and every issue contains at least one gem I find very interesting. He is ahead of me in his amateur radio knowledge so I discover new things every time I read his latest post.

KJ7T also writes an interesting newsletter / blog for his technical content, including Amateur Radio - The Random Wire. I enjoy that KJ7T writes about what he's *doing* that's Zero Retries Interesting. I need to follow his example and actually *do* more experimentation, fun, and operating Amateur Radio. There are *so* many interesting things going on that I want to discuss here in Zero Retries… it's hard to keep up.

…

Drinking From Firehoses

One of the reasons that I love being involved in Amateur Radio is that it's an endless stream of learning opportunities about radio technology. I happily spent many hours this week re-acquainting myself with Amateur Radio Geosynchronous and Geostationary Earth Orbit (GEO) satellites - I couldn't read / watch the background material I found fast enough while preparing what grew to be *the* article in this issue - ***GEO! GEO!! GEO!!!***

Some weeks, like this one, I can't write fast enough. Though I occasionally grumble about the amount of work that goes into putting out Zero Retries every week, weeks like this more than balance out the less-than-great weeks. As ***GEO! GEO!! GEO!!!*** grew, I had to push one, then two mostly complete articles into next week's issue. That's a happy problem to have, I guess.

…

I did a minor refresh of the Zero Retries About page. Nothing major, some details needed an update since 2022-07.

de Steve N8GNJ

GEO! GEO!! GEO!!!

Disclaimer *- Despite my recent (now concluded) involvement with ARDC, this development was news to me. All I know about this topic is what is mentioned in the above article, and other publicly available information.*

From ARDC News 2022-12-13:

> **Bob McGwier, N4HY, Resigning from ARDC Board**
>
> Posted on 2022-12-13 by Dan Romanchik KB6NU
>
> After serving ARDC for two years, Bob McGwier, N4HY, is resigning from the ARDC Board of Directors on December 31, 2022.
>
> Though he is departing our organization as a director, we don't imagine that Bob will be a stranger to ARDC. Bob will continue to be involved in amateur radio, with plans to work with Dr. Jonathan Black of Virginia Tech's Hume Center Aerospace and Ocean Systems Lab on the design and construction of a geostationary satellite payload. The design work will take place on the Virginia Tech campus and will rely heavily on amateur radio groups, such as Ham Radio Science Citizen Investigation (HamSCI). One of the goals of this project will be to protect the 5 and 10 GHz

> amateur radio bands and prevent them from being allocated to other services. Such a project will take a great deal of his time and attention. In addition, Bob wants to avoid any potential concern about conflict of interest should this project eventually request funding from ARDC.
>
> Bob noted, "I love amateur radio, and I want to do all I can to make it better. It has been my pleasure to serve many communities in amateur radio and communications technology over the years, and I am going to continue to do so, just in a different capacity."
>
> Phil Karn, KA9Q, ARDC board president said, "I've known Bob for 40 years. He brought invaluable experience to the ARDC board, and I'm really sorry to see him go. I know, however, that he's going to continue to do great things for amateur radio."
>
> Everyone at ARDC wishes Bob the best on his next endeavors.

First, in my experience as a volunteer member of the ARDC Grants Advisory Committee and my overall involvement with ARDC, N4HY was one of the most effective members of the ARDC Board (from what I was able to observe). His depth of knowledge, his experience as a founder of two successful companies, and most of all his current activity in Amateur Radio all provided ARDC with some needed perspective.

As for the Geosynchronous Earth Orbit (GEO) elements of this announcement…

Wow. *Wow!* WOW!!!

From my perspective, here are the salient points in this article:

- There *is* now a *real* project for a Geosynchronous Earth Orbit (GEO) payload, presumably for the Western hemisphere (since the Eastern hemisphere already has QO-100).
- The project will be led by N4HY, who has long experience, deep connections, and enormous respect in the Amateur Radio Satellite community.
- The project has support from the Hume Center at Virgina Tech for the design and construction work. This implies the availability of focused, capable, and (most importantly) *consistent* design and construction talent. This is critical because capable, consistent *volunteer* labor that made previous Amateur Radio satellites possible has become *scarce*.
- A major difference from the previous attempt to design and build a GEO payload is the existence of ARDC for potential funding of the design, construction, launch, and ongoing operational expenses.

The only reasonable source of information about this project at the moment is that there was significant design work completed for a previous attempt of an Amateur Radio GEO payload for the Western hemisphere. This is a summary from N4HY posted 2016-07-17 about what was accomplished on the previous project:

> The GEO project at Virginia Tech being done jointly with AMSAT and using RINCON Research's AstroSDR has completed our preliminary design review (PDR).
>
> …
>
> The bottom line is we have a design, an air interface document, a ground terminal project plan. We have permission from the US government to put our payload on board their spacecraft. We have been told by FEMA that they will use our capability in times of Emergency if we get it into orbit. Flex Radio has agreed to design1 a high end ground terminal which will be capable of supporting more missions [than] just this one.

In Zero Retries 0012 on 2021-10- 01, I wrote Exploring the Idea of a Geostationary Amateur Radio Satellite for the Western Hemisphere where I dug out some of the archival information for the previous project:

> **Amateur Radio Geostationary Satellite Project**

> The Western Hemisphere almost had an equivalent to QO-100 - a project begun (I think) in 2015, and discussed in 2016 by Virginia Polytechnic Institute and State University (Virginia Tech) called Amateur Radio Geostationary Satellite (ARGS) / Phase 4B. The video presentation2 about ARGS / P4B at the 2016 Digital Communications Conference was exciting! It was an exciting concept and would have been more sophisticated and more capable than QO-100. Unfortunately, the ARGS project / Phase 4B (P4B) project was suspended:
>
> ***AMSAT / Virginia Tech Geostationary Satellite Project (Phase 4B) Status***
> *Virginia Tech continues to investigate opportunities to fly an amateur payload aboard a geostationary or geosynchronous satellite. A Payload Accommodation Study showed that an amateur payload could be carried on a U. S. Government satellite, but that satellite has been delayed indefinitely. While Virginia Tech was offered a spot on a government satellite, the cost, duration of mission, and lack of guarantees that the payload would be activated resulted in that spot being declined. Discussions continue.*

Not mentioned in my article (oops!) was the accompanying paper from the 2016 Digital Communications Conference (DCC):

> **Using Digital Communications and Microwaves in Amateur Radio and in the Amateur Satellite Service**
>
> By Michelle Thompson W5NYV, and Dr. Robert McGwier, N4HY
>
> **Abstract:** One of the biggest revolutions in technology has been the transition from information being represented in analog form to information being represented in digital form. This transition has profoundly affected communications and media of all types. Photography, music and video recording, documents, telephony, and computation have been fundamentally recast in formats that are compressible, storable, filterable, easily copied, and easily shared.
>
> Proceedings Paper

That was Then, This is Now…

It's now six or seven years later and some things have changed to potentially make this new project more viable than the previous project:

- **Saner Schedule** - The previous project's development was severely challenged by the satellite's integration and launch schedule, which put the project at risk, and greater costs necessary to meet that schedule. Hopefully the new project's schedule will be saner.
- **Geostationary?** - The previous satellite would be in a Geosynchronous orbit which (for "set and forget" antenna aiming) is less desirable than Geo*stationary* Earth Orbit.
- **QO-100** - QO-100 has now been in operation as a GEO Amateur Radio payload in the Eastern hemisphere for four years. It has enabled a lot of innovative ground station designs and usage scenarios within its footprint; everything from a dedicated CW transmitter to a dedicated station in Antarctica. Bottom line - Amateur Radio Operators within the footprint of QO-100 are having a lot of fun and making good use of QO-100.
- **Prior Work** - There *was* substantial work done to validate that the previous project *was* viable. For example, digital modulation methods for uplink and downlink were studied and suitable ones were identified that could be implemented using existing technology.
- **ARDC** - ARDC is now well-established as a source of substantial grants. That financial capacity to help fund such a project did not exist until the past few of years.
- **SDR is Mainstream** - Software Defined Radio (SDR) technology above 1 GHz is now routine, and 5 GHz and 10 GHz radios are more common and available. Seven years ago, that wasn't nearly the case.

Note the emergence of the Icom IC-905 designed for Amateur Radio that includes 5 GHz, and an option for 10 GHz.

- **Cheap Compute Power** - We weren't exactly lacking adequate compute power seven years ago, but now we're awash in as much *inexpensive* compute power as we could ever want. The "Amateur Radio" benchmark for embedded / dedicated computer power is the Raspberry Pi 4 with four cores, 64-bit enabled, 1.5 GHz clock speed, and up to 8 GB RAM, all for < $100.

- **Cheaper / Faster / Bigger FPGAs** - I can't speak with authority about Field Programmable Gate Arrays (FPGAs) other than they're becoming ubiquitous in radio systems, even lower end, relatively inexpensive systems such as the CaribouLite RPi HAT Software Defined Transceiver for < $100.

- **ORI ITAR / EAR Work** - Work done by Open Research Institute (ORI) may result in less "friction" about the new project being subjected to onerous regulations from the US State Department (International Traffic in Arms Regulations - ITAR) and US Department of Commerce (Export Administration Regulations).

- **ORI Work on Ground Terminal and Satellite** - In the previous project, ORI worked to design the ground terminal (Phase 4 Ground) as an open source project. When the earlier project was canceled, ORI began working to develop an open source GEO payload (Phase 4 Space). Both projects have been underway for years. Thus there is substantial work done as open source that might help "kickstart" the new project.

- **No DOD Involvement?** - In the previous project, because the payload was to be hosted on a US Department of Defense (DOD) satellite, there was a requirement of a strict "firewall" between the design of the (semi-classified) satellite payload and the design of the (non-classified) ground station. The only interface between the two projects could be the air interface specification. If this new payload isn't hosted on a DOD satellite, perhaps that strict "firewall" can be relaxed for more efficient development. In the video, N4HY mentions that he's discussed the previous project with Inmarsat, Intelsat, and Orbital ATK (now a unit of Northrop Grumman).

- **"Room" at GEO** - Television distribution via satellite is declining in favor of streaming via Internet. In addition, Internet via GEO satellite is declining in favor of using Starlink. It's completely speculation on my part, but those factors might "make some room" for an Amateur Radio payload at GEO especially since it would use spectrum allocated for Amateur Radio at 5 and 10 GHz.

- **M17 Project** - The M17 Project is developing a new digital radio protocol for data and voice specifically for Amateur Radio. Because it's open source, and its CODEC is software, it could be adapted for use with this new project such as incorporating recognition of the latency inherent in using GEO satellites. I'm imagining that a ground station could incorporate M17 protocols for seamless interoperability of M17 users within the GEO footprint. A ground station would be an ideal "backbone" for M17 repeaters. Inclusion of M17 would, to me, provide substantial benefits for both the new project and M17 adoption.

- **EMCOM Moving to Starlink** - The earlier project was partially predicated on providing emergency communications via an Amateur Radio GEO satellite. As I've discussed a number of times here in Zero Retries, emergency communications will increasingly be provided via Starlink with significantly better ease of use, no Amateur Radio license required, no "fussy" aiming at a specific GEO satellite, etc. Thus any "complications" of the new project for EMCOM usage might be reduced.

- **Demonstrated Threats to Amateur Microwave Bands** - In the ARDC article, N4HY said "One of the goals of this project will be to protect the 5 and 10 GHz amateur radio bands and prevent them from being allocated to other services." That's now a credible threat for the Amateur Radio 10 GHz band - see Coalition Asks the FCC to Open the 10 GHz Band for Sharing. US Amateur Radio Operators recently lost its 3.5 GHz band. At the 2023 World Radiocommunication Conference, Amateur Radio access to the 1240 - 1300 MHz band may well be changed substantially. This payload will show why Amateur Microwave spectrum *matters* beyond the occasional microwave contest.

- **Another "Command" Station at MIT?** - In the video, N4HY talks about the Virginia Tech ground station being highly capable as a command station for a GEO satellite. I don't know if it makes a difference to have another highly capable ground station, but ARDC helped fund the renovation of the MIT Radio Club's (W1MX) 18-foot "big dish" on the MIT campus. It should be "back in action" soon. At a minimum, it can't hurt to have a highly capable ground station located at another institution with a lot of energetic technical talent.

Technology

N4HY's presentation at the 2016 DCC is worth watching. In my inexpert opinion, all of the technology choices he discusses (at the time of the previous project) still seem reasonable:

- It's a hosted payload on a GEO satellite, not an independent satellite. Launch, power, cooling, and antennas will all be provided by the host satellite.

- The payload will be, essentially, a Software Defined Radio. All aspects of its operation can be updated via software.

- Frequencies used will be "five and dime" - 5 GHz uplink (ground station transmits on 5 GHz) and 10 GHz downlink (satellite transmits on 10 GHz). The frequency relationship between 5 GHz and 10 GHz makes it conceivable for a single dish to be designed. Alternatively, dedicated transmit and receive dishes might make for simpler, cheaper electronics.

- Both uplink and downlink will be digital. There won't be any analog capability (no linear transponders). Both uplink and downlink will use Forward Error Correction (FEC). The more FEC used, the lower the throughput; the less FEC used, the higher the throughput.

- The payload will continuously transmit a dynamic "map" of unused channels.

- Ground stations will receive the "map" and choose an unused channel and transmit a brief "request to transmit" packet on a special channel. The satellite will send approval to transmit. This will minimize contention for the available uplink channels.

- The uplink is 10 MHz wide, consisting of 1000 channels that are 10 kHz wide. Potentially this could be (dynamically?) repartitioned to 2 kHz channels for voice (using CODEC 2 which requires far less than 2 kHz). If you want to transmit faster, such as a big file, or video, you can also request a block of channels.

- The downlink is a continuous wideband data stream, with the user data from the uplink channel assigned to a time slot in the data stream. It's a simple translation - data from uplink Channel 213 is transmitted in downlink time slot 213. There's no encryption on the downlink - receive / listen / monitor to as much, or as little, as you wish.

- The overall digital technology is DVB-SX2, an open standard used for satellite broadcast video. It has considerable flexibility that (it's hoped) can be adapted to accomplish what's needed. Receivers (again, that are compliant with the specification) will be able to receive DVB-T2, a version that's used for receiving terrestrial video.

- When the previous project was proposed, a significant use case was for emergency communications, and it was desirable to restrict usage to "authorized" stations during a declared emergency, as well as a mechanism that provides authentication of Amateur Radio Operators as authorized users. N4HY's pithy synopsis of the need for authentication:

  I don't want Captain Midnight sending porno through my spacecraft.

- The entire system - spacecraft and ground station, can be modeled / emulated / simulated using Ettus Research hardware and GNU Radio software.

Takeaways

There's no one better… perhaps no one else *that could*… marshal all the disparate resources to make a project of this scope possible. It's impossible not to note the *nexus* that N4HY's creates for such a project - Virginia Tech for development, personal knowledge of much of the necessary technology, deep contacts in the space, electronics, and communications industry, and ARDC. With N4HY heading up this new project, there's at least a reasonable chance to accomplish an Amateur Radio GEO payload for the Western hemisphere.

I couldn't be more excited about this new project! Honestly, I'm thrilled about this project! I will do whatever it takes to get a station for this satellite on the air - build it out of parts, buy an integrated unit, invest the money necessary, commit to learning all about GEO satellite technology, microwaves, all-digital radio technology, etc.

In my opinion, much like Amateur Radio on the International Space Station (ARISS), this project has the potential to excite students, makers, hackers, etc. into getting involved in Amateur Radio. It's one thing to passively use space technology like GPS, satellite broadcasting, even Starlink. As the users of QO-100 have demonstrated, it's quite another (more exciting) thing to put together a *personal* ground station for using a satellite. Building a ground station will be an ideal project for Amateur Radio clubs; I'll guess there will be a lot of ARDC grant proposals submitted to buy or build GEO ground stations for Amateur Radio clubs.

As I discussed in Zero Retries 0001 - Amateur Radio Digital Water Holes
(and Building Community) a "Water Hole" - a resource such as a local simplex channel, a scheduled net on HF, a repeater, or now a GEO payload for an entire hemisphere, enables "community" in Amateur Radio. I can't think of anything that would enable a sense of community from all Amateur Radio Operators in the Western hemisphere than an Amateur Radio GEO payload.

Inevitably, AMSAT-NA will be involved in this project somewhere, so despite my distaste for AMSAT-NA's management missteps of the last several years, it's now time for me to restart my membership. I don't want to miss anything about this project that happens within AMSAT-NA… and with paid membership I can peek behind AMSAT's paywall and view its publications.

As I said to a friend as we discussed ARDC's announcement via email:

To make this real, people are going to have to show up to do the work. ***I plan to be one of them!***

I would add to that

… and help pay for it.

Make no mistake - this new project will be *expensive*. Despite the work completed on the previous project, the numerous donations in kind, N4HY potentially donating his time, Virginia Tech using this project as practical experience for students, the best intentions from whatever satellite company(s) agree to host the payload, and ARDC's grantmaking, **it's going… to… be… expensive!**

Thus I hope that this project will quickly form an effective communications network (regular updates to keep the excitement level high) and a system to channel financial donations to this project. I'll be an early, and regular contributor.

…

As I was researching the background information for this article, I (finally) found a number of references to the "Groundsat" concept - essentially a terrestrial equivalent for the GEO payload. Previously, I had not known where to look. I'll discuss the utility of "Groundsats" for this project in a future issue of Zero Retries.

Join the *Fun* on Amateur Radio

If you're not yet licensed as an Amateur Radio Operator, and would like to join the fun by *literally having a license to experiment with radio technology*, check out

Join the Fun on Amateur Radio for some pointers.

Closing the Channel

In its mission to highlight technological innovation in Amateur Radio, promote Amateur Radio to techies as a literal license to experiment with wireless technology, and make Amateur Radio more relevant to society in the 2020s and beyond, Zero Retries is published via email and web, and is available to anyone at no cost. Zero Retries is proud *not to participate* in the Amateur Radio Publishing Industrial Complex, which hides Amateur Radio content behind paywalls.

My ongoing ***Thanks*** to:

- Tina Stroh KD7WSF for, well, *everything!*
- Pseudostaffers Dan Romanchik KB6NU and Jeff Davis KE9V for continuing to spot, and write about "Zero Retries Interesting" items on his blog that I don't spot on my own.
- Andreas Spiess HB9BLA's YouTube Channel - HB9BLA Wireless features Zero Retries Interesting content.
- Amateur Radio Weekly consistently surfaces "Zero Retries Interesting" stories.
- The Substack email publishing platform makes Zero Retries possible. I recommend it for publishing newsletters.

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More bits from Steve Stroh N8GNJ:

- SuperPacket blog - *Discussing new generations of Amateur Radio Data Communications - beyond Packet Radio (a precursor to Zero Retries)*

- N8GNJ blog - *Amateur Radio Station N8GNJ and the mad science experiments at N8GNJ Labs - Bellingham, Washington, USA*

Thanks for reading!
Steve Stroh N8GNJ / WRPS598 (He / Him / His)
These bits were handcrafted in beautiful Bellingham (The City of Subdued Excitement), Washington, USA.

2022-12-16

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1

Of course, that was then, this is now, but that mention of FlexRadio agreeing to design a ground terminal for this payload slipped by me in my research for the previous article. *Interesting…*

2

Corrected link; was incorrect in the original article.